भारतीय मानक **IS/IEC 60695-2-12 : 2021**

Indian Standard

अग्नि जोखिम परीक्षण

भाग 2 ग्लोइंग/हॉट-वायर आधारित परीक्षण विधियाँ

अनुभाग 12 चमकीला-तार ज्वलनशीलता सूची

(जी डब्ल्यू एफ आई) सामग्री के लिए परीक्षण विधि

(पहला पुनरीक्षण)

Fire Hazard Testing

Part 2 Glowing/Hot-Wire Based Test Methods

Section 12 Glow-Wire Flammability Index

(GWFI) Test Method for Materials

(First Revision)

ICS 13.220.40; 29.020

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March 2023 **Price Group 7**

Environmental Testing Procedure Sectional Committee, LITD 01

NATIONAL FOREWORD

This Indian Standard (Part 2/Section 12) (First Revision) which is identical with IEC 60695-2-12 : 2021 'Fire hazard testing — Part 2-12: Glowing/hot-wire based test methods — Glow-wire flammability index (GWFI) test method for materials' issued by the International Electrotechnical Commission (IEC) was adopted by the Bureau of Indian Standards on the recommendation of the Environmental Testing Procedure Sectional Committee and approval of the Electronics and Information Technology Division Council.

This standard was originally published in 2019 and was identical with IEC 60695-2-12 : 2014. The first revision of this standard has been undertaken to align it with the latest version of IEC 60695-2-12 : 2021.

The text of IEC Standard has been approved as suitable for publication as an Indian Standard without deviations. Certain conventions are however not identical to those used in Indian Standards. Attention is particularly drawn to the following:

a) Wherever the words 'International Standard' appears referring to this standard, they should be read as 'Indian Standard'.
b) Comma (,) has been used as a decimal marker while in Indian Standards, the current practice is to use a point (.) as the decimal marker.

In this adopted standard, reference appears to certain International Standards for which Indian Standards also exist. The corresponding Indian Standards, which are to be substituted in their places, are listed below along with their degree of equivalence for editions indicated:

International Standard	*Corresponding Indian Standard*	*Degree of Equivalence*
IEC 60695-2-10 Fire hazard testing — Part 2-10: Glowing/hot-wire based test methods — Glow-wire apparatus and common test procedure	IS/IEC 60695-2-10 : 2021 Fire hazard testing — Part 2: Glowing/ hot-wire based test methods, Section 10 Glow-wire apparatus and common test procedure	Identical with IEC 60695-2-10 : 2021
IEC 60695-2-13 Fire hazard testing — Part 2-13: Glowing/hot-wire based test methods — Glow-wire ignition temperature (GWIT) test method for materials	IS/IEC 60695 (Part 2/Sec 13) : 2021 Fire hazard testing: Part 2 Glowing hot wire based test methods, Section 13 Glow-wire ignition temperature GWIT test method for materials	Identical with IEC 60695-2-13 : 2021
IEC 60695-4 : 2021 Fire hazard testing — Part 4: Terminology concerning fire tests for electrotechnical products	IS 1885 (Part 84) : 2022 Electrotechnical vocabulary: Part 84 terminology concerning fire tests for electrotechnical products (*second revision*)	Identical
ISO 13943 : 2017 Fire safety — Vocabulary	IS 8757 : 2021 Glossary of terms associated with fire safety (*second revision*)	Identical
ISO 293 Plastics — Compression moulding of test specimens of thermoplastic materials	IS 13360 (Part 2/Sec 1) : 2016 Plastics — Methods of testing: Part 2 Sampling and preparation of test specimens, Section 1 Plastics — Compression moulding of test specimens of thermoplastic materials (*first revision*)	Identical with ISO 293 : 2004

(*Continued on third cover*)

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INTRODUCTION

In the design of any electrotechnical product, the risk of fire and the potential hazards associated with fire need to be considered. In this respect the objective of component, circuit, and product design, as well as the choice of materials, is to reduce to acceptable levels the potential risks of fire during normal operating conditions, reasonable foreseeable abnormal use, malfunction and/or failure. IEC 60695-1-10 [1] [1], together with its companion IEC 60695-1-11 [2], has been developed to provide guidance on how this is to be accomplished.

The primary aims of IEC 60695-1-10 and IEC 60695-1-11 are to provide guidance on how to:

a) prevent ignition caused by an electrically energized component part, and
b) confine any resulting fire within the bounds of the enclosure of the electrotechnical product in the event of ignition.

Secondary aims of IEC 60695-1-10 and IEC 60695-1-11 include the minimization of any flame spread beyond the product's enclosure and the minimization of the harmful effects of fire effluents such as heat, smoke, toxicity and/or corrosivity.

Fires involving electrotechnical products can also be initiated from external non-electrical sources. Considerations of this nature are normally dealt with in the overall fire hazard assessment.

In electrotechnical equipment, overheated metal parts can act as ignition sources. In glow-wire tests, a glowing wire is used to simulate such an ignition source.

IEC 60695-2-10 describes a glow-wire test apparatus and common test procedure, IEC 60695-2-11 [3] describes a glow-wire flammability test for end products, and IEC 60695-2-13 describes a glow-wire ignition temperature (GWIT) test method for materials.

This document describes a glow-wire flammability index test for materials. It is intended to be used to measure, describe, and rank the properties of materials in response to heat caused by contact with an electrically heated wire under controlled laboratory conditions. This may be useful for the evaluation of materials for use in products that may be exposed to excess thermal stress such as a fault current flowing through a wire, overloading of components, and/or bad connections. It is not intended to be used to solely describe or appraise the fire hazard or fire risk of materials, products, or assemblies under actual fire conditions. However, results of this test can be used as elements of a fire hazard assessment which takes into account all of the factors which are pertinent to a particular end use.

This document may involve hazardous materials, operations, and equipment. It does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this document to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

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[1] Numbers in square brackets refer to the bibliography.

Indian Standard

FIRE HAZARD TESTING

PART 2 GLOWING/HOT-WIRE BASED TEST METHODS

SECTION 12 GLOW-WIRE FLAMMABILITY INDEX (GWFI) TEST METHOD FOR FOR MATERIALS

(First Revision)

1 Scope

This part of IEC 60695 specifies the details of the glow-wire test to be applied to test specimens of solid electrical insulating materials or other solid materials for flammability testing to determine the glow-wire flammability index (GWFI).

GWFI is the highest temperature, determined during this standardized procedure, at which the tested material does not ignite or, if it does, extinguishes within 30 s after removal of the glow-wire and is not totally consumed; and molten drips, if they occur, do not ignite the wrapping tissue.

This test method is a materials test carried out on a series of standard test specimens. The data obtained, along with data from the glow-wire ignition temperature (GWIT) test method for materials, IEC 60695-2-13, can then be used in a preselection process in accordance with IEC 60695-1-30 [4] to judge the ability of materials to meet the requirements of IEC 60695-2-11.

NOTE As an outcome of conducting a fire hazard assessment, an appropriate series of preselection flammability and ignition tests can allow a reduction of end product testing.

This basic safety publication focusing on safety test method(s) is primarily intended for use by technical committees in the preparation of safety publications in accordance with the principles laid down in IEC Guide 104 and ISO/IEC Guide 51.

One of the responsibilities of a technical committee is, wherever applicable, to make use of basic safety publications in the preparation of its publications.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60695-2-10, *Fire hazard testing – Part 2-10: Glowing/hot-wire based test methods – Glow-wire apparatus and common test procedure*

IEC 60695-2-13, *Fire hazard testing – Part 2-13: Glowing/hot-wire based test methods – Glow-wire ignition temperature (GWIT) test method for materials*

IEC 60695-4:2021, *Fire hazard testing – Part 4: Terminology concerning fire tests for electrotechnical products*

ISO 291:2008, *Plastics – Standard atmospheres for conditioning and testing*

ISO 293, *Plastics – Compression moulding of test specimens of thermoplastic materials*

ISO 294 (all parts), *Plastics – Injection moulding of test specimens of thermoplastic materials*

ISO 295, *Plastics – Compression moulding of test specimens of thermosetting materials*

ISO 13943:2017, *Fire safety – Vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 13943:2017 and IEC 60695-4:2012, some of which are reproduced below for the user's convenience, and in IEC 60695-2-10 regarding times and durations, and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1
combustion
exothermic reaction of a substance with an oxidizing agent

Note 1 to entry: Combustion generally emits fire effluent accompanied by flames and/or glowing.

[SOURCE: ISO 13943:2017, 3.55]

3.2
flame, noun
rapid, self-sustaining, sub-sonic propagation of combustion in a gaseous medium, usually with emission of light

[SOURCE: ISO 13943:2017, 3.159]

3.3
flame event
sustained flaming and/or glowing combustion

3.4
flammability
ability of a material or product to burn with a flame under specified conditions

[SOURCE: ISO 13943:2017, 3.178]

3.5
glowing, noun
luminosity caused by heat

[SOURCE: ISO 13943:2017, 3.196]

3.6
glowing combustion
combustion of a material in the solid phase without flame but with emission of light from the combustion zone

[SOURCE: ISO 13943:2017, 3.197]

3.7
ignition
DEPRECATED: sustained ignition
<general> initiation of combustion

[SOURCE: ISO 13943:2017, 3.217]

3.8
ignition
DEPRECATED: sustained ignition
<flaming combustion> initiation of sustained flame

[SOURCE: ISO 13943:2017, 3.218]

3.9
molten drip
falling droplet of material which has been softened or liquefied by heat

Note 1 to entry: The droplets can be flaming or not flaming.

[SOURCE: ISO 13943:2017, 3.275]

3.10
preselection
process of assessing and choosing candidate materials, components or subassemblies for making an end product

[SOURCE: IEC 60695-4:2012, 3.2.21]

4 Test specimens

4.1 Test specimen preparation

Test specimens shall be fabricated using the appropriate ISO method, e.g. casting and injection moulding in accordance with the ISO 294 series, compression moulding in accordance with ISO 293 or ISO 295, or transfer moulding to the necessary shape as specified in 4.2. Where this is not possible, the test specimen shall be cut and/or sliced from a representative sample of the material (for example, produced using the same fabrication process as would be used to mould a part of a product).

After any fabrication or cutting operation, all dust and any particles shall be removed from the surface; cut edges shall be fine sanded to a smooth finish.

4.2 Test specimen dimensions

The dimensions of the planar sections of the test specimens shall be at least 60 mm in length and 60 mm in width (measured inside the clamping areas) and shall be provided in all thicknesses under consideration. The preferred values of thickness include 0,1 mm ± 0,02 mm, 0,2 mm ± 0,03 mm, 0,4 mm ± 0,04 mm, 0,75 mm ± 0,15 mm, 1,5 mm ± 0,15 mm, 3,0 mm ± 0,25 mm, or 6,0 mm ± 0,4 mm.

NOTE A set of 30 test specimens per thickness will, in general, be adequate to concurrently establish the GWFI and the glow wire ignition temperature, GWIT (see IEC 60695-2-13).

4.3 Testing ranges in formulations

4.3.1 General

The results of tests carried out on test specimen sets of different colour, thickness, density, molecular mass, anisotropic type/direction, additives, fillers, and/or reinforcements can vary. When agreed between the parties involved, the test programmes outlined in 4.3.2 and 4.3.3 may be employed in order to evaluate these variations.

4.3.2 Density, melt flows and filler/reinforcement

Test specimens covering all combinations of minimum and maximum levels of density, melt flows and filler/reinforcement content shall be provided and considered representative of the range if the test results yield the same GWFI. If the test results do not yield the same GWFI for all test specimens representing the range, evaluation shall be limited to the materials with the specific levels of density, melt flows and filler/reinforcement tested. In addition, test specimens with intermediate density, melt flows, and filler/reinforcement content shall be tested to determine the representative range for each GWFI determination. However, as an alternative, the least favourable performance of the specific levels of density, melt flows and filler/reinforcement tested shall be considered representative of intermediate levels without additional testing.

4.3.3 Colour

When evaluating a range of colours, test specimens that

a) contain no colouring,
b) contain the highest level of organic pigments/colorants/dyes and/or carbon black,
c) contain the highest level of inorganic pigments, and
d) contain pigments/colorants/dyes which are known to adversely affect flammability characteristics

are considered representative of the colour range if the test results yield the same GWFI.

If the colours do not yield the same GWFI, when evaluating a range of colours, the GWFI with the least favourable performance should yield the GWFI for an all colour range.

5 Apparatus

The test apparatus of IEC 60695-2-10 shall be used.

6 Temperature measuring system verification

The verification of the temperature measuring system as specified in IEC 60695-2-10 shall have been performed.

7 Conditioning and test conditions

7.1 Conditioning of test specimens

The test specimens shall be conditioned for a minimum of 48 h at 23 °C ± 2 °C and at a relative humidity between 40 % and 60 % (in accordance with ISO 291:2008, Clause 6, Table 2, Class 2). Once removed from the conditioning atmosphere, the test specimens shall be tested within 4 h.

7.2 Conditioning of the wrapping tissue and the wooden board

The wrapping tissue and the wooden board to be placed underneath the test specimen as well as their conditioning are specified in IEC 60695-2-10. Once removed from the conditioning atmosphere, the wrapping tissue and wooden board shall be used within 4 h.

7.3 Testing conditions

The test specimens shall be tested in a laboratory atmosphere having a temperature between 15 °C and 35 °C and a relative humidity less than or equal to 75 %.

8 Test procedure

8.1 General

The test specimens shall be identified.

The general test procedure shall be as specified in IEC 60695-2-10.

8.2 Initial test temperatures

The glow-wire is heated to one of the initial test temperatures specified in Table 1, which is considered to be just high enough to cause ignition. If unknown, the initial test temperature shall not exceed 650 °C.

NOTE When determining both the GWIT and GWFI, it has been found to be useful to first perform the procedure in IEC 60695-2-13. Once the GWIT has been determined, this information is useful to set the initial test temperature for the GWFI test.

Table 1 – Initial test temperatures

Initial test temperatures °C	Tolerances °C
550	±10
600	±10
650	±10
700	±10
750	±10
800	±15
850	±15
900	±15
960	±15

8.3 Test temperatures

A set of three test specimens shall be prepared for testing at a chosen initial test temperature.

If one of the three test specimens fails to withstand the test criteria as defined in 10.1, the test shall be repeated with three new test specimens at a test temperature preferably 50 °C (60 °C for 960 °C) lower.

If the three test specimens withstand the test criteria as defined in 10.1, the test shall be repeated with three new test specimens at a test temperature preferably 50 °C (60 °C for 900 °C) higher.

Repeat the tests with three new test specimens each time and reduce the interval of test temperatures to 25 °C (30 °C for 960 °C) in the final approach to determine the maximum test temperature at which all three test specimens withstand the test criteria as defined in 10.1.

However, there is no need to go to the higher temperature if it has already been determined that at least one of the three test specimens will not withstand the test criteria as defined in 10.1.

NOTE The minimum test temperature is 550 °C. The maximum test temperature is 960 °C.

9 Observations and measurements

9.1 Initial observations

After identifying and visually inspecting the test specimens, the following shall be recorded:

a) a description of the tested material, including thickness, colour, type and manufacturer;

b) a description of the method for the preparation of the test specimens, if available;

c) the direction of any anisotropy, if known, relative to the dimensions of the test specimen; and

d) the pre-test conditioning of the test specimens and wrapping tissue.

9.2 Test observations

During the time of application of the glow-wire, t_{APP} (30 s ± 1 s), and during a further period of 30 s, time of observation, t_{OBS}, the test specimen and the wrapping tissue placed below it shall be observed and the following shall be recorded:

a) whether there is no ignition; or, if there is ignition, the time of ignition, t_I for the test specimen;

b) the time of extinguishment, t_E;

c) based on the recording of measured values t_I and t_E, the calculated value for t_R shall be recorded as well;

d) the test temperatures from Clause 8;

e) whether the test specimen is totally consumed;

f) whether there is any ignition of the wrapping tissue placed underneath the test specimen; and

g) additional observations that may be agreed to by both parties.

10 Evaluation of test results

10.1 Test criteria

The test specimen is considered to have achieved the severity level of a specific test temperature of T °C, if

a) there is no ignition, or

b) all of the following situations apply when ignition has occurred:

   1) flames or glowing combustion of the test specimen extinguish within 30 s after removal of the glow-wire (t_{OBS}), i.e. $t_R \leq 30$ s;

   2) the test specimen is not totally consumed; and

3) the wrapping tissue placed underneath the test specimen does not ignite.

10.2 Glow-wire flammability index

The GWFI is the highest temperature at which three test specimens at the relevant thickness withstand the test as defined in 10.1.

In those cases where the material under test did not ignite during the determination of the GWIT (see IEC 60695-2-13) at the highest temperature taken from Table 1, the GWFI test procedure need not be conducted. The GWFI for this material will be 960 °C at the relevant thickness.

The GWFI shall be reported in the following manner:

for example, for a test specimen of 3,0 mm thickness and a GWFI temperature of 850 °C:

GWFI: 850 / 3,0

In case of different GWFIs per thickness, these GWFIs shall be reported per thickness.

In those cases where the GWFI is to be utilized over a range of thicknesses, it may be appropriate to consider the GWFI at the minimum and maximum thickness and the other preferred thicknesses in the range.

The GWFI representative for a range of thicknesses shall be reported in the following manner, for example, for a range of thicknesses of 0,75 mm up to 3,0 mm and a GWFI temperature of 850 °C:

GWFI: 850 / 0,75 – 3,0

11 Test report

The test report shall include the following information:

a) a reference to IEC 60695-2-12;

b) the test temperatures from 8.3;

c) the observations and measurements from Clause 9; and

d) the GWFI from 10.2.

Bibliography

[1] IEC 60695-1-10, *Fire hazard testing – Part 1-10: Guidance for assessing the fire hazard of electrotechnical products – General guidelines*

[2] IEC 60695-1-11, *Fire hazard testing – Part 1-11: Guidance for assessing the fire hazard of electrotechnical products – Fire hazard assessment*

[3] IEC 60695-2-11, *Fire hazard testing – Part 2-11: Glowing/hot-wire based test methods – Glow-wire flammability test method for end-products*

[4] IEC 60695-1-30, *Fire hazard testing – Part 1-30: Guidance for assessing the fire hazard of electrotechnical products – Preselection testing process – General guidelines*

(*Continued from second cover*)

International Standard	*Corresponding Indian Standard*	*Degree of Equivalence*
ISO 295 Plastics — Compression moulding of test specimens of thermosetting materials	IS 13360 (Part 2/Sec 2) : 2013 Plastics — Methods of testing: Part 2 sampling and preparation of test specimens, Section 2 Compression moulding of test specimens of thermosetting materials (*first revision*)	Identical with ISO 295 : 2004

The technical committee has reviewed the provision of the following International Standards referred in this adoption standard and has decided that they are aceptable for use in conjunction with this standard.

International Standard	*Title*
ISO 291 : 2008	Plastics — Standard atmospheres for conditioning and testing
ISO 294 (all parts)	Plastics — Injection moulding of test specimens of thermoplastic materials

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 2022 ‘Rules for rounding off numerical values (*second revision*)’. The number of significant places retained in the rounded off value should be same as that of the specified value in this standard.

Bureau of Indian Standards

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Review of Indian Standards

Amendments are issued to standards as the need arises on the basis of comments. Standards are also reviewed periodically; a standard along with amendments is reaffirmed when such review indicates that no changes are needed; if the review indicates that changes are needed, it is taken up for revision. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition by referring to the website-www.bis.gov.in or www.standardsbis.

This Indian Standard has been developed from Doc No.: LITD 01 (20104).

Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected

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Published by BIS, New Delhi